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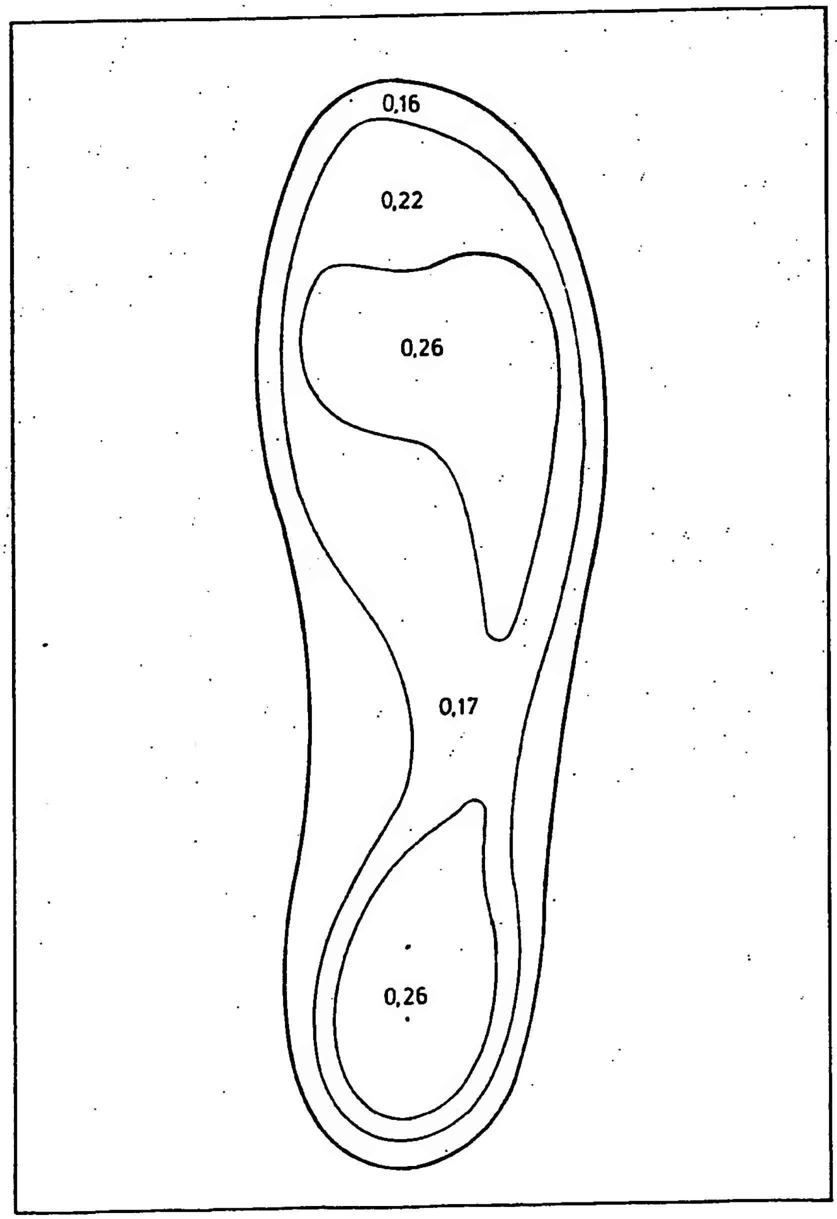
(54) **Insoles**

(57) An insole of closed cell cross-linked polyolefin foam of monolithic structure which comprises zones of varying elasticity which merge into one another. The insole has lower elasticity in areas of high orthopaedic load, and the elasticity is a function of the density of the insole which varies as indicated numerically in the drawing. The insole is formed by heating a smooth sheet of a closed cell cross-linked polyolefin foam until plastic and the forming is a shaped mould.



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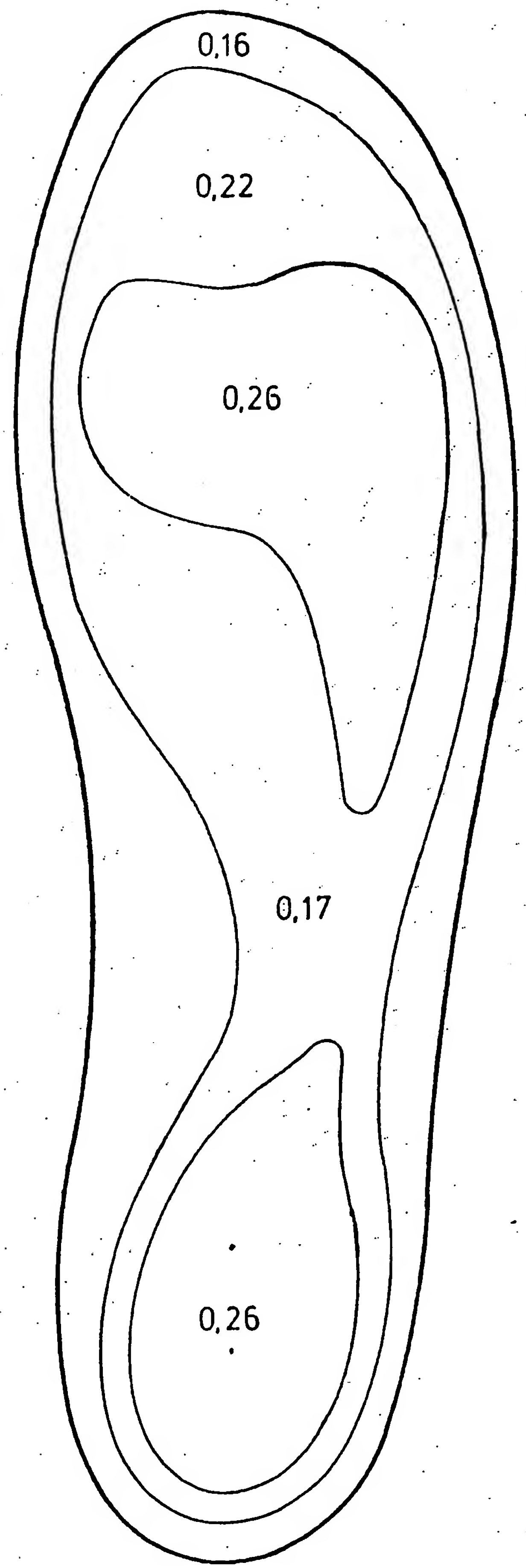

SPECIFICATION

Insoles

This invention relates to shaped insoles having a surface adapted to the shape of the sole of the foot and with zones of varying elasticity.

German Utility Model 7,627,731 discloses orthopaedic insoles. In order to provide such insoles with zones of varying elasticity, it is necessary to unite various component parts of the constituent plastics foam with one another. Accordingly, abrupt transitions between the zones of different elasticity are obtained. Moreover, manufacture of such insoles has proved to be difficult.

According to the present invention, an insole is of closed cell cross-linked polyolefin foam of monolithic structure and comprises zones of varying elasticity which merge into one another, i.e. the variation in elasticity in the plane of the insole is not discontinuous.

The insoles of the invention may form an integral part of an item of footwear, e.g. a boot or shoe, or they may comprise an article suitable for insertion into a preformed item of footwear. When of the latter type, an insert of the invention may be reinforced with a backing material, and in either case a covering layer may be provided. Suitable covering and/or backing materials comprise bonded natural and/or synthetic fibres.

Preferably, the polyolefin foam is a polyethylene foam. The degree of cross-linking of the polyolefin is preferably from 60 to 80%. Such a degree of cross-linking provides the material with a suitable degree of thermoplasticity in preparation coupled with good stability in use.

It is particularly desirable that the polyolefin foam should have a lower elasticity in the areas of high orthopaedic load or stress than in the areas of relatively lower load. It is also preferred that the elasticity of the polyolefin foam should be a function of the density of the foam in the product, so that the elasticity decreases with increasing weight per unit volume. The preferred range of densities for the foam used in the insoles of the invention is from 0.07 to 1, and more preferably from 0.1 to 0.4, kg/dm^3.

The elasticity of the various zones in an insole of the invention can be determined by applying a given load in a particular area and observing the recovery of thickness when the load is removed. A standard manner in which the elasticity can be determined is by using a cylindrical die having a cross-section of 31 mm and a weight of 5 kg. The face of the die positioned on the insole is adapted to conform to the shape of the insole at that point. The die is positioned on the material for six hours and the material is then allowed to recover for 18 hours. The degree of recovery is measured, and an average recovery value can be obtained by repeating the procedure, say, five times. The specific load is of the order of 670 g/cm^2, and it is particularly preferred that the mean recovery of the foam in insoles of the invention should be from 3 to 30% when using such a load.

It is an advantage of the present invention that the insoles are easy to produce. Their production may be achieved by a combined heat and pressure treatment on a homogeneously constructed plastics foam blank with specific dimensions. During production, the shaping process is determined essentially by the mutual overlapping which occurs owing to the different degrees of compression in the various zones of the material. If desired, the elasticity in given areas of the product can be influenced during the shaping process by affecting the flow of material within a given mould in those areas.

It will be appreciated that the insoles of this invention can be produced in moulds having a conventional shape, for mass production, or in moulds which have been shaped on the basis of the orthopaedic requirements of a given wearer.

A schematic plan view of an insole of the invention is illustrated in the accompanying drawing, in which the various zones have been given a specific density value by way of example. It is to be understood that the boundaries between the zones of differing density do in fact merge smoothly into one another. It will be observed that the illustrated insole, in use, will support a foot primarily at the heel and the ball of the foot. Moreover, the whole of the surface of the insole supports the foot, but with an elasticity or softness of varying degree in accordance with the anatomy of the wearer. In particular, as a result of supporting the marginal zones of the foot, a distinct improvement in overall support is achieved, it being of great importance that chafing and similar effects, often observed with prior insoles, are reduced or eliminated. The shaped insert has a low overall weight and is physiologically harmless. It has good stability in use and does not affect, nor is it effected by, foot perspiration.

When an insole of the invention is covered, which will generally be the case, such a covering may influence the elastic behaviour of the product. For example, when the insole is of the type to be inserted in a preformed shoe, and both the over and undersides of the insole are covered, the structure of a sandwich element is obtained in mechanical respects. For example, for use in sports shoes, good overall stability can be achieved by suitable construction without any noticeable impairment of the wear properties having to be accepted as compared with shaped insoles which are not covered. It is therefore possible, and in many cases appropriate, to cover an insole of the invention with a conventional insole.

The following Examples illustrate the invention.

Example 1

A smooth sheet of a closed cell cross-linked polyethylene foam having a thickness of 10 mm, a density of 90 kg/m^3 and a mean cell cross-section of 0.8 mm was cut into the shape of the sole of a shoe and heated on both sides using infra-red radiation apparatus. The source of the infra-red rays was positioned 30 cm above the surface of the sheet and the degree of heating was controlled so that overheating of the surface of the sheet was avoided but the sheet as a whole became plastic. The heated sheet was then placed for 2.5 seconds in a closed mould having a shape such that the upper surface of

the sheet assumed the contours of a human foot and became like an insole.

On opening the mould, the sheet, which was still warm, had a shape suitable for insertion into shoes, the upper surface of the formed sheet having zones of differing but continuously varying elasticity, approximating to what is shown in the drawing. According to the varying elasticity values, the formed sheet was found to have varying thickness.

After the sheet had been fully cooled, it was loaded for 6 hours on each of five consecutive days with a 5000 g cylinder having a diameter of 31 mm in each of the various zones. The circular faces of the cylinders conformed to the structure of the surface of the formed sheet. In this way, a further specific decrease in the thickness of the sheet was observed, as recorded in the following Table. No further decrease in thickness was observed after further tests of this type over 14 days. In fact, an equilibrium was observed, with a constant recovery and a constant thickness at both the loaded and the unloaded states. The thicknesses measured in the state after relieving the load are given in the following Table. The fourth column in the Table gives the relationship between the recovered thickness and that observed under the load, thereby giving a scale of values for the elasticity of the formed sheet in the various zones.

Original thickness (mm)	Loaded thickness (mm)	Recovered thickness (mm)	Recovery (%)
7.5	4.6	5.8	21
6.2	3.8	4.6	17
4.3	3.2	3.4	6
3.1	2.5	2.6	4

The flow relationship, which can be observed from the values given in columns 1 and 2 of the above Table with respect to the load carrying properties of the material, represents a great advantage in that the form of the shoe insert can be individually suited to the foot of the wearer. Accordingly, the elasticity of various regions of the product can be adjusted to suit the requirements of a given wearer.

Example 2

In order to prepare an orthopaedic insert which is specially adapted to reinforce the middle region of the foot, a blank of the type used in Example 1 was milled in a wedge-shape at the front and back, so that the thickness of the blank on its projecting edges was about 50% of the original thickness. The blank was then subjected to the same process of manufacture as that in Example 1. The shoe insert which was produced had a permanent elasticity of 5% in the middle region of the equilibriated surface structure, and the elasticity varied continuously up to a value of 19% in the marginal regions of the product.

CLAIMS

1. An insole of closed cell cross-linked polyolefin foam of monolithic structure which comprises zones of varying elasticity which merge into one another.

2. An insole according to claim 1 in which the foam has a lower elasticity in the areas of high orthopaedic load than in the areas of relatively lower load.

3. An insole according to claim 1 or claim 2 in which the elasticity of the foam is a function of its density and decreases with increasing density.

4. An insole according to any preceding claim in which the density of the foam varies within the range of 0.07 to 1 kg/dm^2.

5. An insole according to claim 4 in which the density of the foam varies within the range of 0.1 to 0.4 kg/dm^3.

6. An insole according to any preceding claim which is covered on its upper and/or its lower surface.

7. An insole according to claim 6 in which the lower covering comprises bonded natural and/or synthetic fibres.

8. An insole according to any preceding claim in which the polyolefin foam is polyethylene foam.

9. An insole according to any preceding claim in which the degree of recovery of the foam from a specific load of 670 g/cm^2 is within the range of 3 to 30%.

10. An insole according to claim 1 substantially as described in either of the Examples.

11. An insole according to claim 1 substantially as illustrated in the accompanying drawing.

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